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Non-destructive depth profiling of Au/Si(100) with X-ray absorption spectroscopy

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1 Introduction

Metal silicides are recently studied for using as silicon-based electronic devices. Among silicides, β-$FeSi_2$ and Mg_2Si are candidates as thermo-electronic devices. Although the information on surface chemical states is important to fabricate silicides with better property, the chemical states are not well understood.

As a non-destructive chemical state analysis method for solids, X-ray photoelectron spectroscopy (XPS) is widely used [1-2]. However, depth profiling is often limited due to insufficient analyzing depth. In order to observe depth profile, additional techniques such as ion irradiation are necessary. Ion irradiation often causes chemical state changes. Non-destructive analysis is therefore required to obtain accurate chemical depth profile.

In the present study, we examined a method to perform depth profiling with X-ray absorption spectroscopy (XAS) by changing electron energies for detection.

2 Experiment

Gold thin films with the thicknesses of 1, 2, 5 and 10 nm were deposited onto Si(100) substrates by resistance heating. The XAS measurements were performed at the beam line 27A. The Si K-edge (1830-1860 eV) and Au M-edge (2720-2800 eV) XAS spectra were measured for these samples. In order to perform depth profiling, XAS spectra were measured by changing electron energies ranging from 5 to 50 eV for detection.

3 Results and Discussion

Figure 1 shows (a) Si K-edge and (b) Au M-edge XAS spectra of an Au film with a thickness of 5 nm. Here, electrons with an energy of 30 eV were detected to obtain XAS spectra. Electrons with energies ranging from 5 to 50 eV were also detected and the Si/Au ratios were calculated from the peak heights of each edge. These Si/Au ratios are plotted against the electron energies as shown in Fig. 2. As can be seen, obvious correlation between the Si/Au ratio and the electron energy is observed. With decreasing electron energy, the ratio increased significantly. This means that by reducing electron energy, information on deeper region of the surface can be obtained. The Si/Au ratio obtained with a total electron yield mode was 0.9, which corresponds to the ratio obtained with the detection of 25 eV electrons. Similar correlation between Si/Au ratio and electron energy was also observed for Au thin films with the thicknesses of 1, 2 and 10 nm. These results indicate that by changing electron energies for detection, it is possible to perform non-destructive depth profiling in XAS analysis. This method will be applied to surface analysis of β-$FeSi_2$ and Mg_2Si samples.

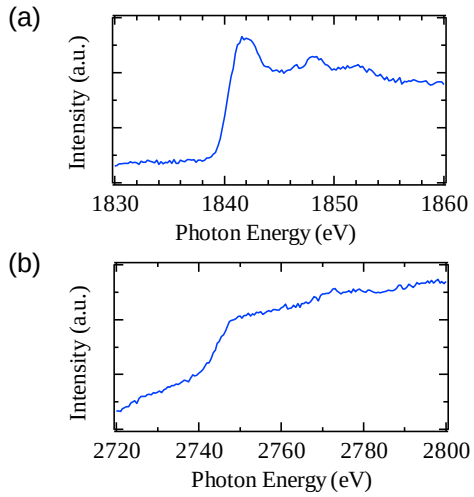

Fig. 1: (a) Si K-edge and (b) Au M-edge XAS spectra of an Au thin film with a thickness of 5 nm.

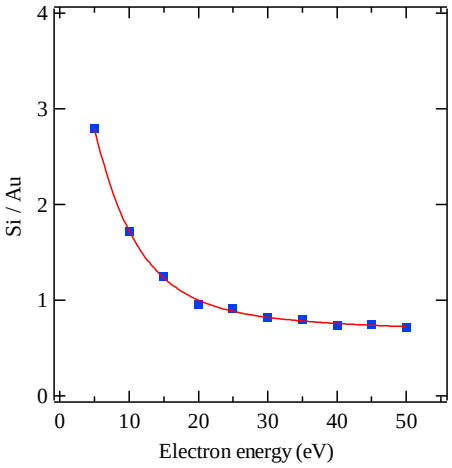

Fig. 2: Si/Au ratios obtained with XAS analysis.

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References

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